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Original research article

THE EFFECTS OF AN EXPERIMENTAL PROGRAM OF SPEED DEVELOPMENT ON PRESCHOOL CHILDREN

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Abstract. *In order to determine the effects of an experimental program for a period of 4 months, the growth rate in preschool children was measured by administrating a battery of three tests (the "20 m dash", "Obstacle course backwards" and "Arm plate tapping"). The sample of consisted of 207 children aged 6-7, 125 of whom were involved in the "Sportska azbuka" (Sports Alphabet) program from Novi Sad (the experimental group), and 82 children of the same age who attended the "Peter Pan" daycare in Novi Sad (the control group). In order to determine the differences between the groups at the point of the initial and the final measuring, the multivariate analysis of variance (MANOVA) was applied for each group, as well as the univariate analysis of variance (ANOVA), which estimated the difference of individual motor variables. In order to determine the effect of the treatment on the transformation of motor abilities between the groups of participants, the multivariate analysis of covariance (MANCOVA) was applied in each age group. The univariate analysis of covariance (ANCOVA) was applied to estimate the difference of individual motor variables. Based on the results of the multivariate analysis of covariance (MANCOVA), it could be concluded that there was an improvement in the results of the experimental group in all three observed variables, hence the speed of preschool children*.

Key words: *preschool, motor skills, speed.*

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INTRODUCTION

According to certain Anglo-Saxon authors, children aged 3 to 5, or sometimes, 3 to 7, are classified as preschoolers. In the professional and contemporary literature, the preschool age often includes the period prior to enrollment in primary school (Đorđić, 2006). Regardless of the classification, one thing is for sure - the preschool age is an extremely sensitive period regarding the motor development of children, especially when it comes to learning and adopting an extensive repertoire of motor skills. It is very important not to miss this period, and the benefits it carries in the formation of a motor foundation. Motor behavior implies resolving problems during movement and the performance of various movements. It includes not only physical, but also intellectual and emotional involvement, that is most prevalent in children in the youngest age group. It has been proven that they participate in motor behavior with their whole being, and their motor performance is of a general type, meaning that at this age there are no differentiated motor skills (Ismail & Gruber, 1971).

Firstly, the speed of movement depends on the development of the muscle-nerve unit. Speed as a complex ability is largely genetically defined (Čoh, 2003) and it rapidly increased in the preschool and early school age (Gallahue & Ozmun, 1998). Preschool children tend to have slower reaction time than older children, and they find it difficult to accurately determine speed, weight, force, acceleration, distance and location (Keogh & Sugden, 1985). The increase of their speed during the pre-puberty period is not the result of muscle contractions, but nervous muscular adjustments, achieved by participation in different games. It is very important that those games and exercises are different in order to aggravate various motor experiences of the child (Bompa, 2000). Although running speed, reaction time and quick footwork are continuously improving from the age of five to maturity (Bompa, 2006), it is recommended that preschoolers work on their speed only when they adopt the techniques of running (Rađo, 2003). In preschool children, it is important to primarily influence the development of coordination, because the delay in the development of this motor skill would have a direct impact on the child's success in performing simple motor exercises, let alone more complex ones (Hands, 2008).

"Sportska azbuka" (Sports Alphabet), which has been implemented in the "Radosno detinjstvo" (Happy Childhood) kindergarten, Novi Sad, Serbia, is a form of organized physical activity of preschool children, and it is the ideal start for practicing physical activity. The goal of "Sportska azbuka" is to provide preschool children with the versatile possibility of their mental and physical development. Children also become a potential base for a variety of sports and experience their first and timely guidance to sports. In this way, the children get affected by the sports lifestyle more easily, they rejoice in games and competitions, and are joyful, fast, strong, durable, skilled, curious, intelligent, and above all, in good health (Janković, 2005).

Therefore, the aim of this study was to determine how the regular physical exercise program called "Sportska azbuka" primarily affects the development of speed in preschool children.

METHODS

Participants

This research included a sample of 207 children aged 6 to 7. The sample was drawn from the population of children attending the "Petar Pan" kindergarten, in the city of Novi Sad (the control group consisted of 82 children) and 125 children who were involved in the "Sportska azbuka" program in Novi Sad (the experimental group).

Instruments and procedure

The "*20m dash*" motor test was used for the evaluation of running speed, while the "*Arm plate tapping*" test was used to estimate the speed of alternative movements. It has already been noted that the motor functioning of young children is of a general type and it is largely conditioned by the level of coordination development. Therefore, for the better understanding of the development of speed, the evaluation of the body coordination was undertaken by applying the "*Obstacle course backwards*" test. All three tests were drawn from a battery of seven tests which were later adapted for children (Bala, Popović & Stupar, 2002; Kulić, 2005). A short description of the motor tests will follow, but a more detailed description, with the entire standardization of the tests, can be found in the "Sportska školica" book (Sport School for Children) (Bala, 2002a). Every child was given an opportunity to practice the test before the results were registered. The following motor ability tests were applied:

1. The 20 m dash. The result is the time it takes a child to run a 20 meter distance from a standing start. The children run in pairs.

2. Arm plate tapping. For fifteen seconds the child has to alternately tap the two plates on the tapping board with his dominant hand, while holding the other hand in between the two plates. The result is the number of alternate double hits.

3. *Obstacle course backwards*. The child has to walk backwards on all fours and cover a distance of 10 meters, climb the top of a vaulting box and go through the frame of the bench. The task is measured in tens of seconds (Bala, 2010).

The exercise program in the "Sportska azbuka" lasted for 4 months, in the period from September 2, 2013 to December 24, 2013. With the financial support from the City Government, the "Radosno detinjstvo" preschool institution and the "Super Aktivan" Sports Association ("Super Active" Sports Association) selected three kindergartens for the realization of the sports education. The choice was determined by the existence of appropriate sports halls and yards for exercising in the kindergartens. Professors of sport and physical education (from the list of unemployed personnel of the National Employment Agency) implemented the program. Educators who were regularly employed in kindergartens were collaborators in the research. The selected children from kindergartens were 6 to 7 years old. The professors were involved in 12 classes - three days for 4 hours, 16 weeks in total. Classes were scheduled in the morning hours. Measurements were carried out at the beginning of September (the initial measurements) and at the end of December (the final measurements). Only those children who had trained during all 4 months continually and who met the health requirements were taken into account. The control group consisted of children from the "Peter Pan" kindergarten, which prepared the preschool program for physical education (Kamenov, 1995).

Table 1 The plan and program of "Sportska azbuka"

September	**October**
Initial testing (motor abilities and morphological characteristics) - **2** classes; **Athletics** (walking and running, stand-up start and block start) - **3** classes; **Gymnastics** (candles, bridge, string) - **3** classes; **Sports Games** (indoor soccer) - **2** classes; **Group games** (dodge ball) - **2** classes.	**Athletics** (the standing long jump and start-up, scissor jumps, jumps over a hurdle and ladder) - **3** classes; **Gymnastics** (beams, scales) - **3** classes; **Sports Games** (mini-soccer) - **2** classes; **Combat sports** (wrestling, karate) - **2** classes; **Traditional dances** - **2** classes.
November	**December**
Athletics (throwing balls, vortex) - **3** classes; **Gymnastics** (roll forward, backward somersault) - **3** classes; **Sports Games** (mini basketball) - **2** classes; **Group games** (with rope) - **2** classes; **Combat sports** (wrestling, judo) - **2** classes.	**Final testing** (motor abilities and morphological characteristics) - **2** classes; **Athletics** (running, throwing, jumping repetition) - **3** classes; **Gymnastics** (a handstand on the head against the wall) 3 classes; **Sports Games** (mini volleyball with balloons) - **2** classes; **Traditional dances** - **2** classes.

Data analysis

The results were analyzed in the SPSS 17.0. statistical package (Statistical Package of Social Sciences – for Windows). The basic central and dispersion parameters (arithmetic mean (M) and standard deviation (SD)) were calculated for each motor test and each group of participants. A multivariate analysis of variance (MANOVA) was used to determine the differences between the groups at the initial and final measuring for each group, while the univariate analysis of variance (ANOVA) was applied for the assessment of individual differences in motor variables. The T-test for dependent samples was applied to determine the differences within each group at the initial and final measuring. The multivariate analysis of covariance (MANCOVA) was applied in order to determine the effects of the treatment on the transformation of motor skills between groups of participants in each age group, while the univariate analysis of covariance (ANCOVA) was applied in order to assess the individual differences in motor variables.

RESULTS

Table 2 Results of multivariate and univariate analyses of variance between the experimental (E) and control (C) groups at the initial measuring

Variable		INITIAL						
		MIN	MAX	M	Se	SD	f	P
20 m dash (s)	E	4.5	7.9	5.43	0.04	0.54	3.21	0.07
	C	4.5	6.7	5.89	0.09	0.82		
Obstacle course backwards (s)	E	12.3	57.7	24.20	0.62	6.95	3.06	0.08
	C	13.4	41.9	25.82	0.65	5.91		
Arm plate tapping (freq.)	E	9.0	22.0	14.89	0.24	2.73	2.10	0.15
	C	10.0	19.0	14.38	0.22	1.99		
		F=1.89	P=0.00					

Legend: M - mean, Se - standard error of mean, SD - standard deviation, f - f-test for univariate analysis of variance, p - level of statistical inference of an individual system of motor variables. F – the F-test for the multivariate analysis of variance, P - the level of significance between groups in the entire space of variables

Multivariate analysis of variance for the three observed characteristics of motor space with a level of significance of P = 0.00 and a low value of F=1.89 indicates that there were no significant differences between these two groups (Table 1.).

Table 3 Results of the multivariate and univariate analyses of variance between the experimental (E) and control (C) groups at the final measuring

Variable		Initial						
		MIN	MAX	M	Se	SD	f	P
20 m dash (s)	E	3.9	6.5	4.95	0.05	0.51	50.62	0.00
	C	4.4	7.8	5.48	0.06	0.57		
Obstacle course backwards (s)	E	10.7	40.8	18.69	0.49	5.50	47.75	0.00
	C	15.2	44.4	24.32	0.69	6.31		
Arm plate tapping (freq.)	E	7.0	29.0	18.50	0.03	0.36	38.58	0.00
	C	10.0	28.0	15.59	0.03	0.27		

F= 26.91 P=0.00

Legend: M - mean, Se - standard error of mean, SD - standard deviation, f - f-test for univariate analysis of variance, p - level of statistical inference of an individual system of motor variables. F – the F-test for multivariate analysis of variance, P - the level of significance between groups in the entire space of variables

Based on the results of the multivariate analysis of variance for the three observed characteristics of motor space with a level of significance of P = 0.00, and a high value of the F-test, it can be concluded that there were significant differences between these two groups. Also, based on the results obtained in all the tested motor variables, statistically significant better results can be observed for the experimental (E) group, compared to the control (C) group at the conclusion of p = 0.00.

Table 4 The differences between the initial and final measuring for the experimental (E) group (t-test for dependent samples).

VARIABLE		AM	r	t	p
20 m dash (s)	E_i	5.43	0.62	11.84	0.00
	E_f	4.94			
Obstacle course backwards (s)	E_i	24.20	0.72	12.63	0.00
	E_f	18.96			
Arm plate tapping (freq.)	E_i	14.89	0.65	-14.59	0.00
	E_f	18.50			

Legend: E_i - experimental group (initial), E_f - experimental group (final), AM - arithmetic mean, r - Pearson's correlation coefficient, t – t-test for dependent samples, p - statistical significance

An analysis of the results in table 4 indicates that the experimental (E) group showed a statistically significant improvement of the results in all the variables, and this conclusion was obtained by comparing the arithmetic means of the initial and the final measuring, which can be inferred on the basis of the sign (-) of the t-test. There was an inversion of the metric in the two variables ("*20m dash*" and "*Obstacle course backwards"*), and the lower results were in fact better results.

Table 5 The differences between the initial and final measuring for the control (C) group (t-test for dependent samples)

Variable		AM	r	t	p
20 m dash (s)	C_i	5.57	0.72	1.88	0.00
	C_f	5.48			
Obstacle course backwards (s)	C_i	25.84	0.69	2.66	0.00
	C_f	24.43			
Arm plate tapping (freq.)	C_i	14.38	0.40	-4.08	0.00
	C_f	15.59			

Legend: C_i - control group (initial), C_f - control group (final), AM - arithmetic mean, r - Pearson's correlation coefficient, t – t-test for dependent samples, p - statistical significance

An analysis of the results in Table 5 leads to the conclusion that there was a statistically significant improvement of the results in all the variables of the control (C) group. This conclusion was made by comparing the arithmetic means of the initial and the final measuring, which can be inferred on the basis of the sign (-) on the t-test.

Table 6 The results (MANCOA) and (ANCOVA) between the experimental (E) and control (C) group at the final measurings

Variable		EMM	Se	F	p
20 m dash (s)	E	4.98	0.35	63.17	0.00
	C	5.43	0.43		
Obstacle course backwards (s)	E	19.17	3.71	58.29	0.00
	C	23.70	4.59		
Arm plate tapping (freq.)	E	18.27	0.23	38.72	0.00
	C	15.92	0.29		

F=39.50 P=0.00

Legend: EMM - estimated marginal means

The high value of the F-test and the level of statistical significance of P = 0.00 clearly indicates that at the multivariate level, regarding the entire system of analyzed motor variables, the experimental group of children was more advanced than the group of children who were not enrolled in the "Sportska azbuka" program. At the univariate level, this difference is mainly due to the "*20m dash*" speed assessment variable, "*Obstacle course backwards*" body coordination assessment variable, and the "*Arm plate tapping*" speed of alternative movement assessment variable (freq.).

Table 7 Post hoc LSD - test with estimated marginal means between the experimental (E) and control (C) groups at the final measuring

Variable	Group	MD	St.e	P
20 m dash (s)	E-C	- 0.49	0.06	0.00
Obstacle course backwards (s)	E-C	- 4.53	0.59	0.00
Arm plate tapping (freq.)	E-C	-2.35	0.37	0.00

F =39.50 P=0.00

Legend: MD - mean difference, St.e - standard error of mean, p - level of statistical significance

Based on the results shown in Table 7, it can be noted that there was a statistically significant difference between the groups at the multivariate level, and based on the results of the univariate analysis of covariance (ANCOVA) it can be concluded that there was a statistically significant difference at the p = 0.00 level in favor of the experimental (E) groups in all three variables: the "*20m dash"*, "*Obstacle course backwards*" and "*Arm plate tapping*".

DISCUSSION

Based on the analysis of the obtained results it can be concluded that, at the beginning of the experiment (initial measuring), there were no statistically significant differences in all forms of motor skills (all three variables) between the preschool experimental and the control group. By analyzing the results of the experimental group, at the final measuring, far better results in all the variables could clearly be noted. Also, we can see a significant improvement of the results at the final measuring, compared to the control group. However, the real and statistically significant improvement of the results were confirmed by the potential procedure of multivariate analysis of covariance (MANCOVA). By analyzing the results in Table 6, we can see improved results in all three variables (which were chosen for the evaluation of speed) in the experimental group, which supports the earlier studies that followed the trend of motor skills of preschool children (Kulić, 2005, Popović, Cvetković & Grujičić, 2006). In similar studies using different experimental programs, an improvement was noted in most motor skills including the speed (Stupar, Popović & Nikolin, 2002; Trajkovski Višić, 2004; Mesaroš-Živkov & Markov, 2008; Džibrić, Huremović & Ahmić, 2009; Rodić, 2010; Stupar, 2011; Savičević, Suzović & Dragić, 2012). In this study, the usage of the experimental program gave statistically significant results in favor of the experimental group, primarily due to the program whose emphasis was on exercises for the development of general coordination and speed. Probably the results of the control group could have been even better if one were to take into account that the program lasted for only four months and in the wintertime, which meant more work indoors. In this case, the experimental treatment took place in small kindergarten halls without the possibility of longer sprints, Stupar (2011). The authors are convinced that if the experimental program lasted more than 4 months (the duration was limited due to a lack of finances) and in the spring months (April, May), the results would certainly have been better.

Of course this is not the only reason for improving the results of the speed measuring tests applied in this study, especially when one considers the numerous applied training facilities, as well as various sprint exercises with fast changes of direction for the development of speed and agility, quick and accurate manipulation of various balls of different shapes, sizes, weights, in standing position, during movement, alone or in couples, improvement of coordination and speed unless, alternative arm movements and lots of jumps, leaps, bounces, etc. are included, which significantly improve the extent of the explosive power of the lower extremities of children.

CONCLUSION

The conclusion, based on the results of this study, could be that after the application of the experimental treatment, the exercise results significantly improved in all of the estimated motor skills (for the estimation of speed) of the experimental group, compared to the group of children who attended a regular physical education program in their preschool. This difference is reflected in the effects of the experimental treatment exercises which lasted for four months and were based on the results of the MANCOVA. The basic prerequisite for the event rate was a thoroughly adopted motor program which has been proven in numerous studies - the frequency of movement is associated with better coordination abilities than the "other types of speed" (Sekulić & Metikoš, 2007). Biotic motor knowledge, which can affect the speed of development, would be the knowledge of overcoming space and obstacles, as well as resistance to biotic and motor skills to manipulate objects. Through various exercises, the children in "Sportska azbuka" developed primarily coordination and speed agility, all aspects of strength, flexibility, balance and other motor skills. This improves all the aspects of coordination in children, who are later better at solving complex motor problems, and who use their resources more rationally and thus allow the rest of their motor skills to be maximally apparent. The more they believe in their capabilities, the better they solve motor problems, become more open, firmer, and communicative. All of this is implemented in their daily life and activities, both at home and in kindergartens, which can significantly affect their personality. Therefore, in the preschool-age group, with the development of coordination, the other aspects of motor skills (speed) are indirectly developed.

Furthermore, for this age group, the game functions as a method for developing motor skills and has crucial importance. The influence of a game on the development of the anthropological characteristics of preschool children is undoubtedly big as they are adopting basic motor skills, collaborating with their peers and the environment in which they are growing up, 'absorbing' the first life experiences, etc. Thus the game, as a daily activity, should be more present in their daily lives (Lorger & Prskalo, 2010). Because of their emotional traits, games and relay games are very suitable as facilities that can affect speed improvement. The advantage of this method is eliminating excessive stress and providing enjoyment and fun during exercise (Bompa, 2006). Furthermore, the game speed development should be performed at the early stages of life, as it has been proved on the example of the 50 meters running time and the start reaction time, which shortens with chronological age. The highest values of running in the 50m (14.523s) and the time of the start of the reaction (0.630) were obtained by three-year-old and four-year-old children while the lowest or best values were obtained by seven-year-old and eight-year-old children (Babić, Blažević & Vlašić, 2010).

However, the authors of this study recommend that trainers and educators who work with this specific population of children primarily work on improving all aspects of coordination, teach them varied movements and positions which will significantly increase their fund of motor knowledge and skills, and enable subsequent optimal development of all other motor abilities, including speed.

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EFEKTI EKSPERIMENTALNOG PROGRAMA NA RAZVIJANJE BRZINE KOD DECE PREDŠKOLSKOG UZRASTA

U cilju utvrđivanja efekata eksperimentalnog programa u trajanju od 4 meseca, na razvijanje brzine kod dece predškolskog uzrasta, primenjena je baterija od tri testa („Trčanje 20 m", „Poligon natraške" i Taping rukom"). Uzorak ispitanika sačinjavalo je 207 dece uzrasta 6-7 godina, od toga 125 uključenih u program „Sportska azbuka" iz Novog Sada (eksperimentalna grupa), kao i 82 dece istog uzrasta koji su pohađali vrtić „Petar Pan" u Novom Sadu (kontrolna grupa). Za utvrđivanje razlika između grupa na inicijalnom i finalnom merenju za svaku grupu primenjena je multivarijatna analiza varijanse (MANOVA), kao i univarijatna analiza varijanse (ANOVA) za procenu razlika pojedinačnih motoričkih varijabli. Za utvrđivanje efekata tretmana na transformaciju motoričkih sposobnosti između grupa ispitanika u svakom uzrastu primenjena je multivarijatna analiza kovarijanse (MANCOVA), kao i univarijatna analiza kovarijanse (ANCOVA) za procenu razlika pojedinačnih motoričkih varijabli. Na osnovu rezultata mulivarijatne analize kovarijanse (MANCOVA) moglo se zaključiti da je došlo do poboljšanja rezultata kod eksperimentalne grupe u sve tri posmatrane varijable, a samim tim i brzine kod dece predškolskog uzrasta.

Ključne reči: *predškolski uzrast, motoričke sposobnosti, brzina*